

WHAT IS CLAIMED IS:

1. An electrochromic medium for use in an electrochromic device, comprising:

- at least one solvent;
- a cathodic electroactive material;
- an anodic electroactive material;

5 - wherein at least one of the cathodic and anodic electroactive materials is

electrochromic; and

- a self-healing cross-linked polymer gel.

10 2. The electrochromic medium according to claim 1, wherein the self-healing cross-linked polymer gel comprises at least one cohesive functional group present in an effective concentration to, in turn, substantially diminish visual irregularities within the same.

15 3. The electrochromic medium according to claim 2, wherein the at least one cohesive functional group is selected from the group comprising a hydroxyl group, acetates, thiols, amines, amides, carboxylic acids, carboxylates, phosphonates, sulfonyl halides, silicate esters, ammonium salts, sulfonyl acids, siloxyls, silyls, cyanos, and combinations thereof.

20 4. The electrochromic medium according to claim 3, wherein the at least one cohesive functional group consists of a hydroxyl group.

5. The electrochromic medium according to claim 2, wherein the self-healing cross-linked polymer gel includes a product of a cross-linking reactant, wherein the cross-linking reactant comprises an isocyanate.

5 6. The electrochromic medium according to claim 1, wherein the self-healing cross-linked polymer gel includes a backbone selected from the group comprising polyamides, polyimides, polycarbonates, polyesters, polyethers, polymethacrylates, polyacrylates, polysilanes, polysiloxanes, polyvinylacetates, polymethacrylonitriles, polyacrylonitriles, polyvinylphenols, polyvinylalcohols, polyvinylidenehalides, and co-polymers and
10 combinations thereof.

7. The electrochromic medium according to claim 1, wherein the cathodic and anodic electroactive materials are linked.

15 8. The electrochromic medium according to claim 1, wherein the at least one solvent is selected from the group comprising 3-methylsulfolane, sulfolane, glutaronitrile, dimethyl sulfoxide, dimethyl formamide, acetonitrile, polyethers including tetraglyme, alcohols including ethoxyethanol, nitriles including 3-hydroxypropionitrile, 2-methylglutaronitrile, ketones including 2-acetylbutyrolactone, cyclopentanone, cyclic esters including beta-
20 propiolactone, gamma-butyrolactone, gamma-valerolactone, propylene carbonate,

ethylene carbonate and homogenous mixtures of the same.

9. The electrochromic medium according to claim 1, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 1mM to approximately 1000mM.

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10. The electrochromic medium according to claim 1, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 5mM to approximately 500mM.

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11. The electrochromic medium according to claim 1, wherein the cathodic electroactive material comprises a viologen.

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12. The electrochromic medium according to claim 1, wherein the cathodic electroactive material comprises a polymer film.

13. The electrochromic medium according to claim 1, wherein the cathodic electroactive material comprises tungsten oxide.

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14. The electrochromic medium according to claim 1, wherein the anodic electroactive material comprises a heterocyclic compound.

5 15. The electrochromic medium according to claim 1, wherein the anodic electroactive material comprises a polymer film.

10 16. The electrochromic medium according to claim 1, wherein the anodic electroactive material is selected from at least one of the group comprising 5,10-dihydro-5,10-dimethylphenazine, 10-methylphenothiazine, a metallocene, and mixtures thereof.

17. An electrochromic medium for use in an electrochromic device, comprising:

- at least one solvent;

- a cathodic electroactive material;

- an anodic electroactive material;

15 - wherein at least one of the cathodic and anodic electroactive materials is

electrochromic;

- a cross-linked polymer gel; and

- means associated with the cross-linked polymer gel for substantially diminishing undesirable visual irregularities within the same.

18. The electrochromic medium according to claim 17, wherein the cross-linked polymer gel comprises at least one cohesive functional group present in an effective concentration to, in turn, substantially diminish visual irregularities within the same.

5 19. The electrochromic medium according to claim 18, wherein the at least one cohesive functional group is selected from the group comprising a hydroxyl group, acetates, thiols, amines, amides, carboxylic acids, carboxylates, phosphonates, sulfonyl halides, silicate esters, ammonium salts, sulfonyl acids, siloxyls, silyls, cyanos, and combinations thereof.

10 20. The electrochromic medium according to claim 19, wherein the at least one cohesive functional group consists of a hydroxyl group.

15 21. The electrochromic medium according to claim 18, wherein the cross-linked polymer gel includes a product of a cross-linking reactant, wherein the cross-linking reactant comprises an isocyanate.

20 22. The electrochromic medium according to claim 17, wherein the cross-linked polymer gel includes a backbone selected from the group comprising polyamides, polyimides, polycarbonates, polyesters, polyethers, polymethacrylates, polyacrylates, polysilanes, polysiloxanes, polyvinylacetates, polymethacrylonitriles, polyacrylonitriles,

polyvinylphenols, polyvinylalcohols, polyvinylidenehalides, and co-polymers and combinations thereof.

23. The electrochromic medium according to claim 17, wherein the cathodic and anodic
5 electroactive materials are linked.

24. The electrochromic medium according to claim 17, wherein the at least one solvent is selected from the group comprising 3-methylsulfolane, sulfolane, glutaronitrile, dimethyl sulfoxide, dimethyl formamide, acetonitrile, polyethers including tetraglyme, alcohols including ethoxyethanol, nitriles including 3-hydroxypropionitrile, 2-methylglutaronitrile, ketones including 2-acetylbutyrolactone, cyclopentanone, cyclic esters including beta-propiolactone, gamma-butyrolactone, gamma-valerolactone, propylene carbonate, ethylene carbonate and homogenous mixtures of the same.
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15 25. The electrochromic medium according to claim 17, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 1mM to approximately 1000mM.

26. The electrochromic medium according to claim 17, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 5mM to approximately 500mM.

5 27. The electrochromic medium according to claim 17, wherein the cathodic electroactive material comprises a viologen.

28. The electrochromic medium according to claim 17, wherein the cathodic electroactive material comprises a polymer film.

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29. The electrochromic medium according to claim 17, wherein the cathodic electroactive material comprises tungsten oxide.

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30. The electrochromic medium according to claim 17, wherein the anodic electroactive material comprises a heterocyclic compound.

31. The electrochromic medium according to claim 17, wherein the anodic electroactive material comprises a polymer film.

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32. The electrochromic medium according to claim 17, wherein the anodic electroactive material is selected from at least one of the group comprising 5,10-dihydro-5,10-dimethylphenazine, 10-methylphenothiazine, a metallocene, and mixtures thereof.

5 33. An electrochromic device, comprising:

- at least one substantially transparent substrate having an electrically conductive material associated therewith; and

- an electrochromic medium which comprises:

- at least one solvent;

- a cathodic electroactive material;

- an anodic electroactive material;

- wherein at least one of the cathodic and anodic electroactive materials is electrochromic; and

- a self-healing cross-linked polymeric gel.

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34. The electrochromic device according to claim 33, wherein the self-healing cross-linked polymer gel comprises at least one cohesive functional group present in an effective concentration to, in turn, substantially diminish visual irregularities within the same.

35. The electrochromic device according to claim 34, wherein the at least one cohesive functional group is selected from the group comprising a hydroxyl group, acetates, thiols, amines, amides, carboxylic acids, carboxylates, phosphonates, sulfonyl halides, silicate esters, ammonium salts, sulfonyl acids, siloxyls, silyls, cyanos, and combinations thereof.

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36. The electrochromic device according to claim 35, wherein the at least one cohesive functional group consists of a hydroxyl group.

37. The electrochromic device according to claim 34, wherein the self-healing cross-linked polymer gel includes a product of a cross-linking reactant, wherein the cross-linking reactant comprises an isocyanate.

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38. The electrochromic device according to claim 33, wherein the self-healing cross-linked polymer gel includes a backbone selected from the group comprising polyamides, polyimides, polycarbonates, polyesters, polyethers, polymethacrylates, polyacrylates, polysilanes, polysiloxanes, polyvinylacetates, polymethacrylonitriles, polyacrylonitriles, polyvinylphenols, polyvinylalcohols, polyvinylidenehalides, and co-polymers and combinations thereof.

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39. The electrochromic device according to claim 33, wherein the cathodic and anodic

electroactive materials are linked.

40. The electrochromic device according to claim 33, wherein the at least one solvent is selected from the group comprising 3-methylsulfolane, sulfolane, glutaronitrile, dimethyl sulfoxide, dimethyl formamide, acetonitrile, polyethers including tetraglyme, alcohols including ethoxyethanol, nitriles including 3-hydroxypropionitrile, 2-methylglutaronitrile, ketones including 2-acetylbutyrolactone, cyclopentanone, cyclic esters including beta-propiolactone, gamma-butyrolactone, gamma-valerolactone, propylene carbonate, ethylene carbonate and homogenous mixtures of the same.

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41. The electrochromic device according to claim 33, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 1mM to approximately 1000mM.

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42. The electrochromic device according to claim 33, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 5mM to approximately 500mM.

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43. The electrochromic device according to claim 33, wherein the cathodic electroactive material comprises a viologen.

44. The electrochromic device according to claim 33, wherein the cathodic electroactive material comprises a polymer film.

45. The electrochromic device according to claim 33, wherein the cathodic electroactive 5 material comprises tungsten oxide.

46. The electrochromic device according to claim 33, wherein the anodic electroactive material comprises a heterocyclic compound.

10 47. The electrochromic device according to claim 33, wherein the anodic electroactive material comprises a polymer film.

48. The electrochromic device according to claim 33, wherein the anodic electroactive material is selected from at least one of the group comprising 5,10-dihydro-5,10- 15 dimethylphenazine, 10-methylphenothiazine, a metallocene, and mixtures thereof.

49. The electrochromic device according to claim 33, comprising a first substantially transparent substrate and a second substrate.

50. The electrochromic device according to claim 49, wherein the device is an electrochromic window.

51. The electrochromic device according to claim 49, wherein the second substrate is plated with a reflective material.

52. The electrochromic device according to claim 51, wherein the reflective material is selected from the group comprising chromium, ruthenium, rhodium, silver, alloys of the same, and stacked layers thereof.

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53. The electrochromic device according to claim 52, wherein the device is an electrochromic mirror.

54. An electrochromic device, comprising:

15 - a first substantially transparent substrate having an electrically conductive material associated therewith;

- a second substantially transparent substrate having an electrically conductive material associated therewith; and

- an electrochromic medium contained within a chamber positioned between the first and second substrates which comprises:

- at least one solvent;
- a cathodic electroactive material;
- an anodic electroactive material, wherein at least one of the anodic and cathodic electroactive materials is electrochromic; and
- 5 - a self-healing cross-linked polymeric gel.

55. The electrochromic device according to claim 54, wherein the self-healing cross-linked polymer gel comprises at least one cohesive functional group present in an effective concentration to, in turn, substantially diminish visual irregularities within the same.

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56. The electrochromic device according to claim 55, wherein the at least one cohesive functional group is selected from the group comprising a hydroxyl group, acetates, thiols, amines, amides, carboxylic acids, carboxylates, phosphonates, sulfonyl halides, silicate esters, ammonium salts, sulfonyl acids, siloxyls, silyls, cyanos, and combinations thereof.

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57. The electrochromic device according to claim 56, wherein the at least one cohesive functional group consists of a hydroxyl group.

58. The electrochromic device according to claim 55, wherein the self-healing cross-linked polymer gel includes a product of a cross-linking reactant, wherein the cross-linking reactant comprises an isocyanate.

5 59. The electrochromic device according to claim 54, wherein the self-healing cross-linked polymer gel includes a backbone selected from the group comprising polyamides, polyimides, polycarbonates, polyesters, polyethers, polymethacrylates, polyacrylates, polysilanes, polysiloxanes, polyvinylacetates, polymethacrylonitriles, polyacrylonitriles, polyvinylphenols, polyvinylalcohols, polyvinylidenehalides, and co-polymers and
10 combinations thereof.

60. The electrochromic device according to claim 54, wherein the cathodic and anodic electroactive materials are linked.

15 61. The electrochromic device according to claim 54, wherein the at least one solvent is selected from the group comprising 3-methylsulfolane, sulfolane, glutaronitrile, dimethyl sulfoxide, dimethyl formamide, acetonitrile, polyethers including tetraglyme, alcohols including ethoxyethanol, nitriles including 3-hydroxypropionitrile, 2-methylglutaronitrile, ketones including 2-acetylbutyrolactone, cyclopentanone, cyclic esters including beta-propiolactone, gamma-butyrolactone, gamma-valerolactone, propylene carbonate,
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ethylene carbonate and homogenous mixtures of the same.

62. The electrochromic device according to claim 54, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 1mM to approximately 1000mM.

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63. The electrochromic device according to claim 54, wherein the concentration of at least one of the cathodic and anodic electrochromic materials ranges from approximately 5mM to approximately 500mM.

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64. The electrochromic device according to claim 54, wherein the cathodic electroactive material comprises a viologen.

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65. The electrochromic device according to claim 54, wherein the cathodic electroactive material comprises a polymer film.

66. The electrochromic device according to claim 54, wherein the cathodic electroactive material comprises tungsten oxide.

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67. The electrochromic device according to claim 54, wherein the anodic electroactive material comprises a heterocyclic compound.

68. The electrochromic device according to claim 54, wherein the anodic electroactive material comprises a polymer film.

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69. The electrochromic device according to claim 54, wherein the anodic electroactive material is selected from at least one of the group comprising 5,10-dihydro-5,10-dimethylphenazine, 10-methylphenothiazine, a metallocene, and mixtures thereof.

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70. The electrochromic device according to claim 54, comprising a first substantially transparent substrate and a second substrate.

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71. The electrochromic device according to claim 70, wherein the device is an electrochromic window.

72. The electrochromic device according to claim 70, wherein the second substrate is plated with a reflective material.

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73. The electrochromic device according to claim 72, wherein the reflective material is

selected from the group comprising chromium, ruthenium, rhodium, silver, alloys of the same, and stacked layers thereof.

74. The electrochromic device according to claim 73, wherein the device is an
5 electrochromic mirror.

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